May 13, 1947. R. B. NELSON 2,420,559

ARTIFICIAL TRANSMISSION LINE

Filed July 26, 1943

Fig. 1.

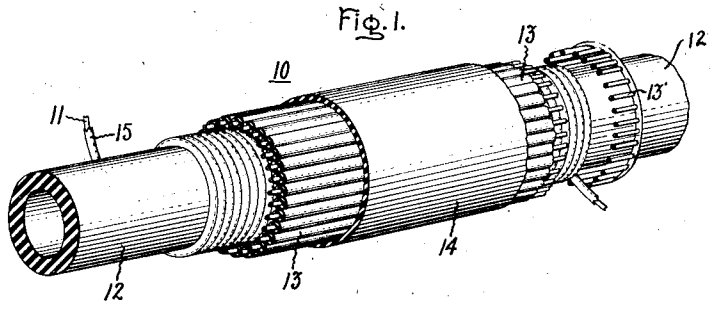
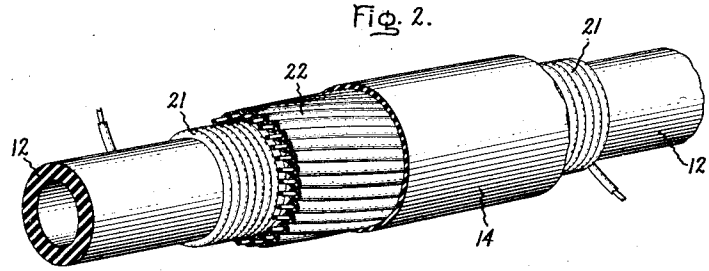


Fig. 2.



Inventor:
Richard B. Nelson,
by Harry E. Dunham
His Attorney.

Patented May 13, 1947

2,420,559

UNITED STATES PATENT OFFICE

2,420,559

ARTIFICIAL TRANSMISSION LINE

Richard B. Nelson, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application July 26, 1943, Serial No. 496,139

6 Claims. (Cl. 178—44)

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My invention relates to high frequency transmission systems and it has for its object to provide an improved artificial transmission line for such a system.

In high frequency signalling systems and, in particular, in pulse signalling systems it is frequently desired to delay the transmission of a signal for a definite period of time in order to initiate operation of certain component apparatus of the system. For example, in a pulse signalling system, it may be desired to delay the transmission of a signal for a period of time sufficient to initiate operation of the sweep circuit of a cathode ray oscilloscope employed in the system. Accordingly, it is an object of my invention to provide a new and improved artificial transmission line which delays the transmission of a signal for a determinable interval of time.

It is another object of my invention to provide a new and improved transmission line which is simply and easily constructed.

A further object of my invention is to provide means for producing a determinable delay in the transmission of a high frequency signal with a minimum attenuation and distortion of the signal.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 shows one form of the artificial transmission line of my invention and Fig. 2 illustrates a modification of the transmission line of Fig. 1.

Referring to Fig. 1, I have shown the artificial transmission line 10 as comprising an insulated conductor 11 formed into a helical coil of closely wound turns supported on a substantially cylindrical form 12 of dielectric material and surrounded by a layer of substantially parallel insulated conductors 13, the conductors 13 being enclosed by a suitable dielectric material 14.

The conductor 11, preferably, is a solid copper wire covered with a suitable insulating material 15, such as enamel. The conductors 13 may be constructed and insulated the same as conductor 11, or may be formed as a braid of insulated conductors. The insulating form 12, preferably, is substantially rigid and may be constituted by any suitable dielectric material, for example, molded polyvinylidene chloride.

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The conductors 13, as shown in Fig. 1, are arranged substantially parallel to the axis of the helical coil formed by conductor 11, are insulated from each other throughout their length, and are connected together by a soldered connection 13' at one or both ends or at any desired intermediate point or points to form a grounded conductor of the transmission line 10. In this way, the layer of outer conductors 13, when operated at ground potential, forms an electrostatic shield, grounded either at many points or continuously, in which but a small circulating current is induced by the field of the current flowing in the helical coil 11. At the same time, the large number of openings between the parallel wires 13 in the outer layer allows the magnetic flux set up by the currents flowing in the coil 11 to penetrate this layer easily, giving to the line a large inductance while keeping the capacity between the conductors substantially large also. As a result, the unitary structure thus formed operates as an artificial transmission line having a relatively large time delay because of the high inductance and capacitance of the line. Such a line is particularly adapted for use in pulse signalling systems for the transmission of square waves of voltage. The resultant attenuation is quite small and but a small amount of distortion is introduced in the wave being transmitted. Since such a line is a three terminal device, in which the terminal connected to conductors 13 is grounded, it is easily coupled between adjacent circuits of a signalling system to introduce a desired amount of delay during transmission of a signal.

In the modification of the invention shown in Fig. 2, the helical coil 21 is surrounded by a layer of parallel insulated wires 22 which are wound about the coil 21 with a long pitch so that each of the wires 22 is inclined at a large angle with the individual turns of coil 21. Such a construction is more readily adapted to machine winding and facilitates production of the artificial transmission line units. As an alternative in form, each of the conductors 22 may be formed of litz wire, that is, a plurality of fine copper strands, braided together and each strand being insulated from the remaining ones, the insulation being necessary to prevent the formation of a short-circuited turn which would reduce the inductance of the inner coil.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since various modifications may be made, and I con-

template by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An artificial transmission line comprising an insulated inner conductor formed into a helical coil of closely wound turns and closely surrounded by a plurality of closely spaced insulated wires substantially parallel to the axis of said coil, said wires being connected together at a point to form an outer conductor of said transmission line, said line having solid dielectric material disposed between said inner and outer conductors and having an electrical length greater than several wavelengths at the frequency of currents transmitted thereover.

2. An artificial transmission line comprising a conductor formed into a helical coil of closely wound turns, said turns being insulated from each other, a plurality of conductors comprising closely spaced insulated wires extending in directions substantially parallel to the axis of said coil and substantially completely surrounding said coil, said plurality of conductors being insulated throughout their lengths from each other and from said turns and being connected together at one of their ends, said line having solid dielectric material disposed between said coiled conductor and said plurality of conductors and having an electrical length greater than several wavelengths at the frequency of currents transmitted thereover.

3. An artificial transmission line comprising a conductor formed into a helical coil of closely wound turns, said turns being insulated from each other, a plurality of conductors comprising closely spaced insulated wires extending in directions inclined at large angles to planes through said turns and substantially completely surrounding said coil, said plurality of conductors being insulated throughout their lengths from each other and from said turns and being connected together at one of their ends, said line having solid dielectric material disposed between said coiled conductor and said plurality of conductors and having an electrical length greater than several wavelengths at the frequency of currents transmitted thereover.

4. In combination, a substantially cylindrical form of dielectric material, a conductor closely wound thereon to form a helical coil, and a layer of closely spaced parallel conductors comprising wires closely surrounding said coil and extending in a direction substantially parallel to the axis of said coil, the turns of said coil being insulated from each other and from said layer of parallel conductors by solid dielectric material and said parallel conductors being insulated from each other substantially throughout their length, said coiled conductor and said parallel conductors forming an artificial transmission line having an electrical length greater than several wavelengths at the frequency of currents transmitted thereover.

5. An artificial transmission line comprising an insulated conductor formed into a helical coil of closely wound turns and closely surrounded by a layer of closely spaced insulated wires, said wires being conductively connected at a point along said coil and being wound about said coil with a long pitch, said line having solid dielectric material disposed between said conductor and said wires and having an electrical length greater than several wavelengths at the frequency of currents transmitted thereover.

6. An artificial transmission line comprising an insulated conductor formed into a helical coil of closely wound turns and closely surrounded by a layer of closely spaced insulated wires, said wires being conductively connected at one of their ends and being inclined at a large angle with the planes of said turns, said line having solid dielectric material disposed between said conductor and said wires and having an electrical length greater than several wavelengths at the frequency of currents transmitted thereover.

RICHARD B. NELSON.

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The following references are of record in the file of this patent:

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